60. (b) At rest at top.

$f_s \leq \mu_s mg \cos\theta$

$f_s = mg \sin\theta$

$$\mu_s \geq \frac{\sin\theta}{\cos\theta}$$

$\mu_s \geq \underline{\tan\theta}$

61. $F = \mu mg = ma$. $a = -\mu g = -0.8(9.8) = -7.84$ m/s^2.
Use Eq. (2–10c). $v^2 = 20^2 + 2(-7.84)(15) > 0$.
Therefore, yes. v = 12.8 m/s

62. Given: $v_o = 0$, $v = 14$ m/s, $t = 8.0$ s, $m = 1000$ kg

$$\max a = \frac{v - v_o}{t} = \frac{14 \text{ m/s}}{8 \text{ s}} = 1.75 \text{ m/s}^2,$$

$\max F = ma = (1000 \text{ kg})(1.75 \text{ m/s}^2) = \underline{1750 \text{ N}}$.

$\Sigma F_y = F_N - mg\cos\theta = 0$

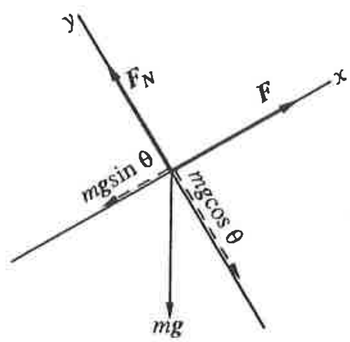
$F_N = mg\cos\theta$

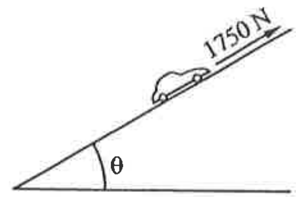
$\Sigma F_x = F - mg\sin\theta = 0$

$F = mg\sin\theta$

$$\sin\theta = \frac{F}{mg}$$

$$\theta = \sin^{-1}\frac{F}{mg} = \sin^{-1}\left[\frac{1750 \text{ N}}{9800 \text{ N}}\right] = \underline{10.3^\circ}$$





63. (a) Weight resolved downhill is $mg \sin\theta = (80 \text{ kg})(9.8 \text{ m/s}^2)(\sin 4^\circ) = c(6 \text{ km/h})$ for no acceleration.
Hence $c = \underline{9.1 \text{ N h/km}}$.

(b) The extra force to achieve 20 km/h is (20 km/h − 6 km/h)9.1 = 127 N.

Chapter 5

1. 1800 km/h = 500 m/s
   v^2/r = (500 m/s)^2/(4000 m) = 62.5 m/s^2 = 6.38 g

2. (a) v^2/r = (1.25 m/s)^2/(11.0 m) = 0.142 m/s^2

   (b) (25.0 kg)(0.142 m/s^2) = 3.55 N

3. $a = (2\pi r/T)^2/r$ = (1.5 × 10^{11} m)(2π/3.15 × 10^7 s)^2 = 5.97 × 10^{-3} m/s^2.
   $F = ma$ = (5.98 × 10^{24} kg)(5.97 × 10^{-3} m/s^2) = 3.57 × 10^{22} N.

4. 26.0 N = (0.80 kg)v^2/(0.50 m)
   v = 4.03 m/s

5. $\mu mg = mv^2/r$
   (0.60)(1000 kg)(9.80 m/s^2) = (1000 kg) v^2/(85 m)
   v = 22 m/s
   Yes, independent at mass.

6. 55 km/h = 15.3 m/s
   $\mu mg = mv^2/r$
   μ = (15.3 m/s)^2/(68 m)/(9.80 m/s^2)
   μ = 0.351

7. 42 rpm
   v = 42(2π)(0.13 m)/(60 s) = 0.578 m/s
   $\mu mg = mv^2/r$
   μ = (9.80 m/s^2) = (0.578 m/s)^2/(0.13 m)
   μ = 0.26

8. All force for centripetal acceleration is being provided by gravity as pressure on seat is just zero. $mg = mv^2/r$. v^2 = (8 m)(9.8 m/s^2). v = 8.85 m/s.

9. $L/T^2 = a = v^c r^d = (L/T)^c L^d = L^{c+d}/T^c$. Hence $c = 2$, $d = -1$.

10. $T = \dfrac{mv^2}{r}$

30v = (0.35 kg)v²/(1.3 m)
v = <u>10.6 m/s</u>
Since friction is along line of motion at the ball, and tension is perpendicular to that line, friction would make <u>no difference</u>.

11. (a) $T + mg = mv^2/r$. $T = (0.335)[-9.8 + (3.25)^2/0.85] =$ <u>0.880 N</u>.

(b) $T - mg = mv^2/r$. $T = (0.335)[9.8 + (3.25)^2/0.85] =$ <u>7.45 N</u>.

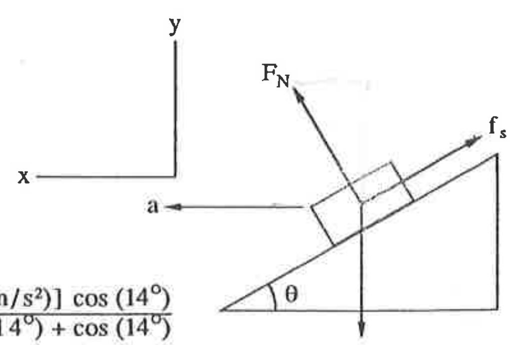
12. $\dfrac{mv^2}{L} = mg$. Hence <u>$v = (Lg)^{\frac{1}{2}}$</u>

13. On outer mass m_2, $T_2 = m_2 v_2^2/r_2 = m_2(r_2\omega)^2/r_2 = (2\pi f)^2 m_2 r_2$, $T = m_2 r_2 \omega$
On inner mass m_1, $T_1 - T_2 = m_1 v_1^2/r_1$
$T_1 = T_2 + m_1(r_1\omega)^2/r_1$
$T_1 =$ <u>$m_2 r_2 \omega^2 + m_1 r_1 \omega^2$</u> $= (2\pi f)^2(m_1 r_1 + m_2 r_2)$

14. $a_c = (2.0\ \text{m})[(1.1)(2\pi)s^{-1}]^2 = 95.5\ \text{m/s}^2$
Must have $\mu m a_c \geq mg$
So $\mu \geq (9.8\ \text{m/s}^2)/(95\ \text{m/s}^2) =$ <u>0.103</u>

15. $\tan\theta = [v^2/rg] = [(16.7\ \text{m/s})^2/(60\ \text{m})/(9.8\ \text{m/s}^2)] = 0.472$.
Vertically: $F_N \cos\theta = \mu F_N \sin\theta + mg$.
Horizontally: $F_N \sin\theta + \mu F_N \cos\theta = mV^2/r$.
Hence $\mu = \tan\theta[(V/v)^2 - 1]/(1 + (\tan\theta\, V/v)^2)] =$ <u>0.393</u>.

16. Assume f_s up slope. 90 km/h = 25 m/s
Vertically, $F_N \cos\theta - mg + mg\, f_s \sin\theta = 0$
Horizontally, $F_N \sin\theta - f_s \cos\theta = mv^2/r$
$f_s = \mu_s F_N$



Solving, $\mu_s = \dfrac{\sin\theta - (v^2/rg)\cos\theta}{(v^2/rg)\sin\theta + \cos\theta}$

$= \dfrac{\sin(14^\circ) - (25\ \text{m/s})^2/[(65\ \text{m})(9.80\ \text{m/s}^2)]\cos(14^\circ)}{(25\ \text{m/s})^2/[(65\ \text{m})(9.80\ \text{m/s}^2)]\sin(14^\circ) + \cos(14^\circ)}$

$= -0.588$

So <u>friction is needed, directed down the slope</u>. (Car is going too fast)
$f_s = \mu mg/[\cos(14^\circ) + (-0.588)\sin(14^\circ)] =$ <u>6960 N</u>

17. Tangential Force = (1000 kg)(3.2 m/s²) = <u>3200 N</u>
Radial Force = (1000 kg)(1.8 m/s²) = <u>1800 N</u>

18. distance = $2\pi(100\text{ m}) = 628\text{ m}$
Use eq (2–10c). $2a_T(628\text{ m}) = (40\text{ m/s})^2 - (0\text{ m/s})^2$, $a_T = 1.27\text{ m/s}^2$
At halfway point, $d = 314\text{ m}$
$2(1.27\text{ m/s}^2)(314\text{ m}) = v^2 - (0\text{ m/s}^2)$
$v = 28.3\text{ m/s}$
$a_r = v^2/r = (28.3\text{ m/s})^2/(100\text{ m}) = 8.00\text{ m/s}^2$

19. $a_r = a \sin\theta = (1.25\text{ m/s}^2)\sin(28^\circ) = 0.587\text{ m/s}^2$
$a_t = a\cos\theta = (1.25\text{ m/s}^2)\cos(28^\circ) = 1.10\text{ m/s}^2$

(a) $a_r = v^2/r$
$0.587\text{ m/s}^2 = v^2/(3.60\text{ m})$
$v = \underline{1.45\text{ m/s}}$

(b) Use eq
$v = 1.45\text{ m/s} + (1.10\text{ m/s}^2)(2.00\text{ s}) = \underline{3.66\text{ m/s}}$

20. distance travelled in 2 s = $\frac{2\pi r}{4}$M
$d = (\pi)$m.

Using eq (2–10b), $\pi = \frac{1}{2}a_T t^2$

$\frac{2\pi}{4}(\text{m/s}^2) = a_T \Rightarrow a_T = \frac{\pi}{2}\text{ m/s}^2$

using $v = v_0 + a_T t$

$$v = \left[\frac{2\pi}{4}\text{ m/s}^2\right](2\text{ s}) = \pi\text{ m/s}.$$

speed at $t = 2.0$ s is $\underline{\pi\text{ m/s}}$ (3.142 m/s)

(b) $\bar{v} = \frac{\Delta\bar{s}}{\Delta t} = \frac{\sqrt{8}}{2} = \underline{1.414\text{ m/s}}$ in a direction <u>45 S of E</u>

(c) $\bar{a} = \frac{\Delta\bar{v}}{\Delta t} = \frac{3.142\text{ m/s}}{2\text{ s}} = \underline{1.57\text{ m/s}^2}$ in the direction <u>straight down</u>.

21. $F = (6.67\times10^{-11})(60)(80)/(10)^2 = \underline{3.2\times10^{-9}\text{ N}}$
When touching, $F = (6.67\times10^{-11})(60)(80)/(0.3)^2 = \underline{3.6\times10^{-6}\text{ N}}$

22. $F = (6.67 \times 10^{-11})(9)(5.98 \times 10^{24})/(6.37 \times 10^6 + 12.8 \times 10^6)^2 = \underline{9.77\ \text{N}}$

23. $g = GM/r^2 = (6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2)(7.4 \times 10^{22}\ \text{kg})/(1.7 \times 10^6\ \text{m})^2 = \underline{1.7\ \text{m/s}^2}$.

24. By proportion, $g_P/g = (R/2.6R)^2$. Thus $g_P = \underline{1.45\ \text{m/s}^2}$.

25. $g_P/g = 2.5$ m/m, $g_P = \underline{24.5\ \text{m/s}^2}$.

26. $g_p/g = (100\ \text{M/M})(R/20\ R)^2 = 0.25$. $g_p = \underline{2.45\ \text{m/s}^2}$.

27. The force varies inversely as the square of the distance.
Thus $d = 5 \times 6.37 \times 10^6\ \text{m} = \underline{3.19 \times 10^7\ \text{m}}$.

28. (a) Mass of ball is same $\underline{4.0\ \text{kg}}$.

(b) On earth $w = (4\ \text{kg})(9.8\ \text{m/s}^2) = \underline{39.2\ \text{N}}$. On the planet $w = mg = (4\ \text{kg})(2\ \text{m/s}^2) = \underline{8\ \text{N}}$.

29. $R = (3\ M/4\pi\rho)^{\frac{1}{3}}$. Thus $g = GM/R^2 = GM^{\frac{1}{3}}(4\pi\rho/3)^{\frac{2}{3}}$. If mass doubles g increases by $2^{\frac{1}{3}}$;
i.e. weight increases by $\underline{1.26}$.

30. (a) $(9.8\ \text{m/s}^2)(6.38 \times 10^6\ \text{m})^2/(6.38 \times 10^6\ \text{m} + 3.2 \times 10^3\ \text{m})^2 = \underline{9.79\ \text{m/s}^2}$.

(b) $(9.8\ \text{m/s}^2)(6.38 \times 10^6\ \text{m})^2/(6.38 \times 10^6\ \text{m} + 3.2 \times 10^6\ \text{m}) = \underline{4.34\ \text{m/s}^2}$.

31. $(2\pi/T)^2R = Gm/R^2$.
Hence $m = (2\pi/3.15 \times 10^7)^2(1.5 \times 10^{11})^3/(6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2) = \underline{2.01 \times 10^{30}\ \text{kg}}$.

32. $g = GM/r^2$
$r_M = (3400\ \text{km})/(6380\ \text{km})r_e = 0.533\ r_e$
$0.38\ g = GM_M/(0.533r_e)^2$
$M_M = (0.108)g(r_e^2/G) = 0.108\ M_e = (0.108)(5.98 \times 10^{24}\ \text{kg}) = 6.48 \times 10^{23}\ \text{kg}$

33. $M = \dfrac{4\pi^2 r^3}{GT^2} = \dfrac{4\pi^2(1.50 \times 10^{11}\ \text{m})^3}{(6.67 \times 10^{-11})(3.16 \times 10^7\text{s})^2}$, T = 365 days (24 h/day)(3600 s/h) = 3.156×10^7 s

$M = 2.01 \times 10^{30}$ kg

34. $200 - 15(9.8) = 15a$. a = <u>3.53 m/s² up</u>

35. $mv^2/(R_e + h) = mg' = mg[R_e/(R_e + h)]^2$.
Hence $v^2 = (9.8\ \text{m/s}^2)(6.37 \times 10^6\ \text{m})^2/(6.37 \times 10^6\ \text{m} + 3.2 \times 10^6\ \text{m})$.
v = <u>6.45×10^3 m/s, in tangential direction</u>

36. (a) Period = 1 day = 86,400 s.
$v = 2\pi r/T$

$$\frac{GM_M}{r^2} = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{GM_e}{r}}$$

Solving,
$r^3 = GM_eT^2/4\pi^2$
$r^3 = (6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2)(5.98 \times 10^{24}\ \text{kg})(86\ 400\ \text{s})^2/4\pi^2$
$r = 4.23 \times 10^7$ m
height = 4.23×10^7 m $- 6.38 \times 10^6$ m = <u>3.59×10^7 m</u>

(b) $v = 2\pi r/T = 2\pi(4.23 \times 10^7\ \text{m})/(86\ 400\ \text{s})$ = <u>3.08×10^3 m/s, in tangential direction</u>

37. Because of Newton's third law the <u>upthrust</u> on the woman from the scale is what registered as the weight, w. Use $F = ma$.

(a) $mg - w = 0$, $w = (54\ \text{kg})(9.8\ \text{m/s}^2)$ = <u>530 N</u>.

(b) $mg - w = 0$, w = <u>530 N</u>.

(c) $w - mg = ma$, $w = (54\ \text{kg})(9.8\ \text{m/s}^2)(1 + 0.33)$ = <u>700 N</u>.

(d) $mg - w = ma$, $w = (54\ \text{kg})(9.8\ \text{m/s}^2)(1 - 0.33)$ = <u>350 N</u>.

(e) $mg - w = ma$, $w = 0$.

38. F_N – reaction of chair on person.
At the top.

$$mg - F_N = \frac{mv^2}{r}.$$

Apparent weight is $R = mg - \dfrac{mv^2}{r}$.

using $v = \dfrac{2\pi r}{T} \Rightarrow \dfrac{v^2}{r} = \dfrac{4\pi^2 r}{T^2}$.

$$\frac{v^2}{r} = \frac{(4\pi^2)(11.25\ \text{m})}{(12.5\ \text{s})^2} = 2.84\ \text{m/s}^2$$

$R = m(g - a_c) = m(6.96\ \text{m/s}^2)$
$R = 8.9\ m.$

$$\text{fractional change} = \left[\frac{6.96\ m - 9.8\ m}{m(9.8)}\right] = \underline{-.290}$$

At the bottom, $R = mg + \dfrac{mv^2}{r}$

$R = m(g + a) = m(12.64)$

$$\text{fractional change} = \frac{12.64\ m - 9.80\ m}{9.80\ m} = \underline{+.290}$$

39. (a) $mg - w = ma = 0.$
$w = (65\ \text{kg})(6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2)(7.4 \times 10^{22}\ \text{kg})/(4.2 \times 10^6\ \text{m})^2 = \underline{18.2\ \text{N}}$ towards the moon.

(b) $18.2\ \text{N} - w = (65\ \text{kg})(3.6\ \text{m/s}^2)$, $w = \underline{-2.2 \times 10^2\ \text{N}}$, i.e., away from moon.

40.

Let the satellite be at a distance r from the center of the planet; then for circular motion

$$\frac{M_S v^2}{r} = \frac{G M_S M_P}{r^2} \qquad M_P \text{ – mass of planet.}$$

$$v = \sqrt{\frac{GM_P}{r}}$$

using $v = \dfrac{2\pi r}{T} \Rightarrow$

$$\left[\frac{2\pi r}{T}\right]^2 = \frac{GM_P}{r}$$

$$M_P = \frac{4\pi^2 r^3}{T^2 G}$$

41. From problem 40 $\Rightarrow$

$$\rho = \frac{M_P}{\text{Volume}} = \frac{4\pi^2 r^3/T^2G}{\frac{4}{3}\pi r^3}$$

$$\rho = \underline{\frac{3\pi}{GT^2}}$$

42. (a) $F = (6.67 \times 10^{-11}\ \text{N. m}^2/\text{kg}^2)(2 \times 10^{30}\ \text{kg})(5.98 \times 10^{24}\ \text{kg})/(1.50 \times 10^{11}\ \text{m})^2 = \underline{3.55 \times 10^{22}\ \text{N}}$.
For the moon
$F = (6.67 \times 10^{-11}\ \text{N . m}^2/\text{kg}^2)(7.4 \times 10^{22}\ \text{kg})(5.98 \times 10^{24}\ \text{kg})/(3.84 \times 10^8\ \text{m})^2$
$= \underline{2.00 \times 10^{20}\ \text{N}}$.

(b) The earth is falling into the sun so it is "weightless." The sun's gravity is exactly canceled by the earth's acceleration. The tidal effect is due to the fact that the day side of the earth feels a slightly stronger pull than the night side does. Only the center of the earth exactly cancels the sun's pull. The tidal "g" is proportional to $GMs[Rs^{-2} - (Rs + Re)^{-2}] \simeq (GMs2Re)/Rs^3$. This inverse cube law is why the moon with its smaller distance beats the sun.

43. $(T/27.4\ d)^2 = (6.37 \times 10^6\ \text{m}/3.84 \times 10^8\ \text{m})^3$. Thus $T = \underline{1.41\ \text{h}}$.

44. Use Kepler's law using the earth as a reference planet. $(r/(1.5 \times 10^{11}\ \text{m}))^3 = (410\ d/365\ d)^2$.
$r = \underline{1.62 \times 10^{11}\ \text{m}}$.

45. $T_N^2/(1\ \text{yr})^2 = (4.5 \times 10^9\ \text{km})^3/(1.5 \times 10^8\ \text{m})^3$
$T_N = \underline{164\ \text{yr}}$

46. From problem 40.

$$T^2 = \frac{4\pi^2 r^3}{M_E G}$$

$$M_E = \frac{4\pi^2 r^3}{T^2 G} \Rightarrow$$

$$M_E = \frac{(4\pi^2)(3.84 \times 10^8)^3}{(2.361 \times 10^6)^2 \times 6.67 \times 10^{-11}}\ \text{kg}$$

$$M_E = \underline{6.0 \times 10^{24}\ \text{kg}}.$$

47. $r = (3 \times 10^4)(3.0 \times 10^8\ \text{m/s})(3.16 \times 10^7\ \text{s}) = 2.84 \times 10^{20}\ \text{m}$
$T^2/(2.84 \times 10^{20}\ \text{m})^3 = 4\pi^2/[(6.67 \times 10^{-11}\ \text{N . m}^2/\text{kg}^2)(4 \times 10^{41}\ \text{kg})]$
$T = 5.82 \times 10^{15}\ \text{s} = \underline{1.8 \times 10^8\ \text{yr}}$

48. (a) $M_I = 4\pi^2(422 \times 10^6)^3/(6.67 \times 10^{-11})/(1.77 \times 86\ 400)^2 = \underline{1.901 \times 10^{27}\ \text{kg}}$

(b) $M_B = 4\pi^2(671 \times 10^6)^3/(6.67 \times 10^{-11})(3.55 \times 86\ 400)^2 = \underline{1.900 \times 10^{27}\ \text{kg}}$
$M_G = 4\pi^2(1070 \times 10^6)^3/(6.67 \times 10^{-11})/(7.16 \times 86\ 400)^2 = \underline{1.895 \times 10^{27}\ \text{kg}}$
$M_C = 4\pi^2(1883 \times 10^6)^3/(6.67 \times 10^{-11})/(16.7 \times 86\ 400)^2 = \underline{1.898 \times 10^{27}\ \text{kg}}$
Results consistent.

49. From eq (5–5a), $r = (GMT^2/4\pi^2)^{\frac{1}{3}}$
$r_I = \underline{4.22 \times 10^8\ \text{m}}$; $r_E = \underline{6.71 \times 10^8\ \text{m}}$; $r_G = \underline{10.71 \times 10^8\ \text{m}}$; $r_C = \underline{18.84 \times 10^8\ \text{m}}$. All compare well.

50. In a short time interval T at the turning points the arc length is vT. Hence the triangle area swept out is $0.5\ v_P d_P = 0.5\ v_N d_N$. Hence $(v_N/v_P) = (d_P/d_N)$.

(b) The average velocity around the sun is $(2\pi R/T) = (2\pi \times 1.50 \times 10^{11}/3.15 \times 10^7\ \text{s}) = 2.99 \times 10^4$ m/s. But $v_N/v_P = (1.52/1.47) = 1.03$. This is a swing of 3%. Hence estimating a swing of plus or minus 1.5% gives $\underline{v_N = 3.03 \times 10^4\ \text{m/s and}\ v_B = 2.95 \times 10^4\ \text{m/s}}$.

51. This happens when $d = (2)^{\frac{1}{2}}\ 6.37 \times 10^6$ m. Therefore height $= \underline{2.64 \times 10^3\ \text{km}}$.

52. $T - mg = \dfrac{mv^2}{r}$

$$1200 - 85 \times 9.8 = \frac{85 \times v^2}{4.8\ \text{m}}$$

$$367 = \frac{85\ v^2}{4.8}$$

$$v = 4.55\ \text{m/s}.$$

53. The pressure on the water must be zero at top of swing. The centripetal acceleration is provided by gravity. Thus $mg = mv^2/r$, $v = \underline{(rg)^{\frac{1}{2}}}$.

54. $\omega = m(g - (2\pi/T)^2 r)$. Hence $\Delta g = -(2\pi/8.64 \times 10^4)^2(6.38 \times 10^6\ \text{m}) = \underline{0.0337\ \text{m/s}^2}$.
$\Delta g/g = \underline{3.44 \times 10^{-3}}$.

55. Let d be distance from center of earth. $(Me/d^2 = Mm/(R - d)^2$.
Therefore $(5.98 \times 10^{24}\ \text{kg})/d^2 = (7.4 \times 10^{22}\ \text{kg})/(3.84 \times 10^8\ \text{m} - d)^2$.
Solving for d, gives $d = 3.45 \times 10^8$ m.

56. (a) Person can walk on the inside of the outer surface.

(b) $a = \dfrac{v^2}{r} = \left[\dfrac{2\pi r}{T}\right]^2 \dfrac{1}{r} = \left[\dfrac{2\pi}{T}\right]^2 r$

$$T = 2\pi\sqrt{\frac{r}{g}} = 2\pi\sqrt{\frac{600\ \text{m}}{9.8\ \text{m/s}^2}} \Rightarrow T = 49.16\ \text{s}$$

$$\#\ \text{of rev per day} = \frac{8.64 \times 10^4}{49.16}\ \text{rev/d} = \underline{1.8 \times 10^3\ \text{rev/d}}$$

57. (a) Assuming $6g$ is the centripedal acc.

$$a = \frac{v^2}{r} \Rightarrow r = \frac{v^2}{a}$$

$$r = \frac{(194.44\ \text{m/s})^2}{(6 \times 9.8\ \text{m/s}^2)} = \underline{6.4 \times 10^2\ \text{m}}.$$

(b) Effective weight = (80 kg)(7 × 9.8 m/s^2)
Effective wt = <u>5488 N</u>.

58. $g = GM/r^2$. $\underline{M = r^2 g/G}$

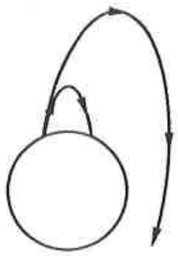
59. $\tan\theta = F_M/F_E$. $\theta = \arctan\,[M_M D_E^2/M_E D_M^2]$

60. 90 km/h = 25 m/s
Vertically, $F_N \cos\theta - \mu F_N \sin\theta = mg$
Horizontally, $F_N \sin\theta + \mu F_N \cos\theta = mv^2/r$
This assumes friction force is directed up the slope. If friction is down the slope, use $-\mu$.

Solving, $\underline{\left[\dfrac{\sin\theta + \mu\cos\theta}{\cos\theta - \mu\sin\theta}\right] = \dfrac{v^2}{rg}}$

To find bank angle, assume $\mu = 0$
$\tan\theta = v^2/rg = (25\ \text{m/s})^2/[(70\ \text{m})(9.8\ \text{m/s}^2)]$
$\theta = 42.3°$
$\underline{v_{max} = 33.8\ \text{m/s} = 122\ \text{km/h}}$
$\underline{v_{min} = 20.5\ \text{m/s} = 74\ \text{km/s}}$

61. $\left[\dfrac{2\pi}{T}\right]^2 R = g$, $g = 9.8\ \text{m/s}^2$ and $R = 6.37 \times 10^6$ m. Solving, $T = (5066\ \text{s})/(3600\ \text{s/h}) = \underline{1.41\ \text{h}}$.

62. 

Best explanation due to Newton. Consider a projectile being thrown faster and faster from the spherical earth. It still falls to meet the earth, but the earth curves away from it. The two suns fall together but never touch.

(b) $m(2\pi/T)^2 r = Gm^2/(2r)^2$.
$m = 4(4 \times 10^{10})^3(2\pi/3.98 \times 10^8\ s)^2/(6.67 \times 10^{-11}\ N \cdot m^2/kg^2) = \underline{9.57 \times 10^{26}\ kg}$.

Chapter 6

1. $W = Fd = mgh = (55)(9.8)(5) = \underline{2.7 \times 10^3 \text{ J}}$

2. (a) $(150)(3) = \underline{450 \text{ J}}$.

   (b) $(650)(3) = \underline{1950 \text{ J}}$

3. $W = Fd = \mu mgd = (0.06)(200)(9.8)(50\ 000) = \underline{5.9 \times 10^6 \text{ J}}$

4. $F = W/d = 6 \times 10^4/2000 = \underline{30 \text{ N}}$

5. Work stored is $mgh = (200 \text{ kg})(9.8 \text{ m/s}^2)h = 13000$ J. $h = \underline{6.63 \text{ m}}$.

6. Vertical distance = (245 m) sin (22.5°) = 93.8 m

   (a) $(1000 \text{ kg})(9.8 \text{ m/s}^2)(93.8 \text{ m}) = \underline{9.19 \times 10^5 \text{ J}}$

   (b) Friction force = $(0.30)(1000 \text{ kg})(9.80 \text{ m/s}^2) \cos(22.5°) = 2716$ N
   Friction work = $(2716 \text{ N})(245 \text{ m}) = 6.65 \times 10^5$ J
   Total work = $9.19 \times 10^5 \text{ J} + 6.65 \times 10^6 \text{ J} = \underline{1.58 \times 10^6 \text{ J}}$

7. (80 N)(0.36 m) = 29 J

8. 1st brick: work = 0 J
   2nd brick: work = $(1.2 \text{ kg})(9.8 \text{ m/s}^2)(0.060 \text{ m}) = 0.7056$ J
   3rd brick: work = $2 \times (0.7056 \text{ J})$
   4th brick: work = $3 \times (0.7056 \text{ J})$
   .
   .
   .
   8th brick: work = $7 \times (0.7056 \text{ J}) =$
   Total work = $(0.7056 \text{ J})(1 + 2 + 3 + 4 + 5 + 6 + 7) = 19.8 \text{ J} = 20$ J